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Chapter 8
Other Water Quality Constituents

This chapter discusses water quality parameters that are either regulated by national and State law or are of current monitoring interests. Federal or California drinking water standards have been established for most of these parameters in the form of primary or secondary maximum contaminant levels (MCLs). The federal government established these primary and secondary MCLs. Primary MCLs are enforceable, and the secondary standards are non-enforceable. The California Department of Health Services (DHS) has primacy for implementing the federal Clean Water Act in California, which requires state agencies and all public drinking water systems to adopt their own MCLs that are at least as stringent as the federal standards. Through California's Safe Drinking Water Act, primary and secondary MCLs have been promulgated with the difference that California secondary MCLs are enforceable. Constituents discussed here include metallic ions, some inorganic constituents, and organics that affect taste, odor, and appearance of drinking water.

Constituents Affecting Taste, Odor, and Appearance

Among the constituents that affect taste, odor, and appearance of drinking water, turbidity, methyl tertiary-butyl ether (MTBE), aluminum, copper, iron, manganese, silver, and zinc were monitored by the Municipal Water Quality Investigations (MWQI) Program of the California Department of Water Resources (DWR). Turbidity is presented in Chapter 7. The remaining constituents are presented here.

Methyl Tertiary-Butyl Ether

MTBE is an organic additive to gasoline products. This organic compound is often detected above its detection limit and sometimes at high levels in groundwater wells near gas stations with leaky underground storage tanks. Although its adverse health effects at the levels found in surface waters and groundwater remain unknown, MTBE can impart an objectionable odor and taste to drinking water.

DHS set an enforceable primary drinking water MCL for MTBE at 0.013 mg/L. A secondary MCL of 0.005 mg/L is also enforceable in California. Of the 650 weekly or monthly samples collected, MTBE was detected at or above its reporting limit of 0.001 mg/L in 159 samples or 24.5% (Table 8-1). No analyses exceeded either the primary or secondary MCL of DHS. Average and median MTBE varied from 0.001 to 0.002 mg/L, which are below DHS primary and secondary MCLs.

Table 8-1 Summary of MTBE data for 14 MWQI monitoring stations

Concentrations of MTBE were never detected at the American River station, the Mallard Island station, or the 2 agricultural drainage stations at Bacon and Twitchell islands (Table 8-1). MTBE was seldom detected at the Vernalis station or at the Natomas East Main Drainage Canal (NEMDC).

However, it was frequently detected in the Sacramento River and in channel waters (Old River). For example, 53% of the weekly samples collected at the Hood station had MTBE at or above its reporting limit. Urban runoff and recreational boating activities may be attributable to the presence of MTBE in the Sacramento River and in Sacramento-San Joaquin Delta channels. Despite these positive detections, concentrations in both rivers never exceeded 0.005 mg/L. At the 3 diversion stations, MTBE was detected at or above the reporting limit in approximately 29% of the samples; however, concentrations were low. Such low MTBE concentrations in Delta source waters were already below its primary and secondary MCLs. Due to its high volatility, MTBE evaporates easily with disturbances and temperature changes during water treatment processes; therefore, these low MTBE concentrations did not appear to cause concern on finished drinking water.

Metallic Constituents

In addition to MTBE, several other constituents—aluminum, copper, iron, manganese, silver, and zinc—affect the taste, odor, or appearance of finished drinking water. Historical data indicate that these constituents were not a threat to Delta waters (DWR 1994, DWR 2001, Woodard 2000). Regular monitoring of these constituents may not be necessary at all stations. Thus, MWQI monitored them at only 3 stations—Banks Pumping Plant, Delta-Mendota Canal, and NEMDC. Data collected during the reporting period suggest that concentrations of the 6 constituents were seldom above their MCLs except for aluminum, iron, and manganese at the NEMDC station (Table 8-2). Of the 38 samples collected at NEMDC, only 2 samples had aluminum above its MCL of 0.2 mg/L. Manganese exceeded its MCL in 6 of the 38 samples. Inflow from NEMDC is relatively small. When water from NEMDC is mixed with water from the American River, both aluminum and manganese will be significantly lower than their MCLs. Therefore, both aluminum and manganese were low at the diversion stations. Among these 6 constituents, silver and zinc were never detected above their detection limits.

Table 8-2 Summary of data for metallic constituents

Article 19 of the *Standard Provisions for Water Supply Contract* (DWR 1962) set specific objectives for copper, iron, manganese, and zinc. Concentrations of all 4 constituents never exceeded the specified maximum concentrations.

Constituents Affecting Human Health

Constituents that may adversely affect human health from exposure above their MCLs include aluminum, antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium (total), copper, cyanide, fluoride, lead, mercury, nickel, nitrate, nitrite, selenium, and thallium. Aluminum and copper are presented in Table 8-2. Nine constituents—antimony, arsenic, barium, cadmium, chromium, lead, mercury, nickel, and selenium—were monitored at the 2 diversion stations. Arsenic was also monitored at an urban drainage. These constituents were not routinely monitored at all MWQI stations because historical data indicate that they did not appear to threaten quality of Delta source waters (DWR 1994, DWR 2001, Woodard 2000).

Three of the 9 monitored contaminants—antimony, cadmium, and lead—were never detected at or above their respective reporting limits (Table 8-3). Barium and mercury were each detected once, but concentration was much lower than their respective MCLs. Selenium was occasionally detected at or above its reporting limit, but average and median concentrations of selenium were much lower than its MCL of 0.05 mg/L. Nickel was detected in most samples, but the highest concentration was 0.002 mg/L, which was 2% of the MCL; the average and median nickel concentrations were only 1% of the MCL. Although concentrations were low, arsenic was found in all samples collected at the diversion stations. Arsenic was higher at NEMDC than at the diversion stations, but concentrations were always lower than the MCL for arsenic. In addition, water inflows from NEMDC were small. Therefore, NEMDC should not be a major contributor of arsenic. The sources of arsenic throughout the Delta remain unclear. The health effects of arsenic are complex and not entirely understood, but it is clear that arsenic concentrations in source waters should be kept as low as possible. Arsenic monitoring throughout the Delta region should continue in Delta source waters.

Table 8-3 Summary of regulated constituents in drinking water having federal and State primary MCLs

Article 19 of the *Standard Provisions for Water Supply Contract* specifies objectives for arsenic, chromium, lead, and selenium (DWR 1962). During the reporting period, concentrations of all 4 constituents never exceeded the maximum concentrations.

Boron

Boron is not regulated, but California requires monitoring of boron in drinking water. The DHS action level (AL) for boron is 1 mg/L. ALs are based on health advisory levels of contaminants that have no primary MCLs. ALs are not enforceable, but exceeding them prompts statutory requirements and recommendations by DHS for consumer notice. At higher levels, source removal may be recommended.

Boron is high in the Delta and may represent a concern in water of small isolated areas near or at geological faults. For instance, average boron at an agricultural drain in south Delta was 12.4 mg/L in 34 samples collected from March 1988 to April 1993 (McCune 2002 pers comm).

During the reporting period, boron was never detected at or above its reporting limit in the American River at the E.A. Fairbairn Water Treatment Plant (WTP) Intake, at the Sacramento River at Hood, or at the Sacramento River at the West Sacramento WTP (Table 8-4). Although boron was frequently detected at or above its reporting limit in waters from the San Joaquin River (SJR) stations, channel waters, agricultural drainage stations, and at NEMDC, concentrations were all below the DHS AL of 1 mg/L. At the diversion stations, average boron concentration was from 0.2 to 0.3 mg/L, which was also below boron's AL. Boron concentrations at the diversions stations did not exceed its Article 19 specified monthly average of 0.6 mg/L.

Table 8-4 Summary of boron data at MWQI stations

Nutrients

Among various nutrients, nitrate and nitrite are mandatory health-related constituents with established drinking water standards requiring monitoring. The primary MCLs for nitrate and nitrite are 45 mg NO_3/L and 1 mg NO_2/L, respectively. During the reporting period, nitrate was monitored at all stations. Although nitrate as a contaminant never exceeded its MCL (Table 8-5), nitrate concentrations were high in the SJR and the Old River and were also high in the agricultural and urban drainage sites. Consequently, nitrate was moderately high at all of the diversion stations (Table 8-5). These high nitrate levels indicated high total nitrogen reserves in Delta waters. High levels of nitrogen and phosphorus collectively promote the growth of algae and, subsequently, affect water quality by increasing concentrations of organic carbon, turbidity, and by forming taste and odor-producing compounds.

Table 8-5 Summary of nitrate data at MWQI stations

Despite some slight variations, nitrate at the diversion stations was generally higher in the wet months of each year and lower in the dry months (Figure 8-1(a)). Lowered nitrate concentration during the dry months may be partly attributable to increased agal activities in the rivers and channels of the Delta. Nitrate concentration in the SJR as measured at the Vernalis station is much higher than in the Sacramento River as measured at the Hood station (Figure 8-1(b)). Although a wet month nitrogen buildup and an early dry month decline were also observed in both rivers, seasonal changes of nitrogen in the rivers were different from those at the diversion stations. Nitrogen levels in both rivers began to rise in June of each year and reached the highest levels between July and October (Figure 8-1(b)), which coincide with the agricultural drainage inflows to both rivers.

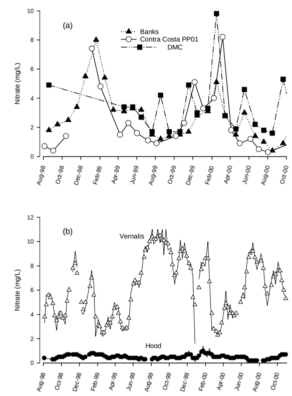


Figure 8-1 Nitrate at three diversion stations and two river stations

At the Banks Pumping Plant, ammonia, Kjeldahl nitrogen, and phosphorus were also monitored in addition to nitrate (Figure 8-2). Kjeldahl nitrogen, which includes organic forms of nitrogen, ranged from 0.3 to 0.8 mg/L with average and median concentrations of 0.5 and 0.4 mg N/L, respectively. The sum of nitrate and nitrite was from 0.13 to 1.20 mg N/L (Table 8-6). Ammonia was frequently detected at low levels at the Banks Pumping Plant. Total phosphorus, which represents total phosphorus in unfiltered samples, at the Banks station ranged from 0.07 to 0.16 mg P/L with average and median levels of 0.11 and 0.10 mg P/L, respectively. About 60% to 70% of the total phosphorus was dissolved orthophosphate (Table 8-6).

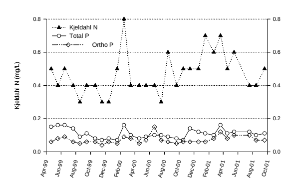


Figure 8-2 Nutrients at the Banks Pumping Plant station

Seasonal changes of Kjeldahl nitrogen at Banks mostly followed similar cyclic patterns found for nitrate, but the magnitude of seasonal changes was smaller (data not shown). Differences in magnitude occurred because Kjeldahl nitrogen represents organic forms of nitrogen, which must be converted to inorganic forms before it becomes bioavailable. Seasonal patterns were less obvious for both total phosphorus and orthophosphate. Both forms of phosphorus remained relatively stable with some slight increases from February to April and some decline during July and August of each year, presumably due to algal consumption of orthophosphates and nitrogen.

Table 8-6 Summary of nutrient data at the Banks Pumping Plant

Although nutrient levels were generally high in most Delta waters, concentrations of nitrate and the sum of nitrate and nitrite never exceeded their respective primary MCLs set by DHS. These primary MCLs are 45 mg/L for nitrate and 10 mg N/L for the sum of nitrate and nitrite.

Table 8-1 Summary of MTBE at 14 MWQI monitoring stations

Station	Positive detects/ samples	Range	Average	Median
		----------------------------mg/L---------------------–		
American and Sacramento River stations				
American River at E.A. Fairbairn WTP	0/37	<0.001	-	-
West Sacramento WTP Intake	6/37	0.001–0.002	0.001	0.001
Sacramento River at Hood	84/159	0.001–0.005	0.002	0.002
Sacramento River at Mallard Island	0/35	<0.001	-	-
San Joaquin River stations				
San Joaquin River near Vernalis	2/160	0.001–0.002	0.001	0.001
San Joaquin River at Highway 4	8/36	0.001–0.004	0.002	0.002
Delta channel stations				
Old River at Station 9	25/37	0.001–0.004	0.002	0.002
Old River at Bacon Island	13/38	0.001–0.002	0.001	0.001
Delta diversion stations				
Banks Pumping Plant	8/29	0.001–0.002	0.001	0.001
Delta-Mendota Canal	5/7	0.001–0.003	0.002	0.001
Contra Costa Pumping Plant	6/30	0.001–0.003	0.002	0.002
Agricultural drainage stations				
Bacon Island Pumping Plant	0/4	<0.001	-	-
Twitchell Island Pumping Plant	0/3	<0.001	-	-
Urban drainage station				
Natomas East Main Drainage Canal	2/38	0.001–0.001	0.001	0.001

Table 8-2 Summary of data for metallic constituents

Constituent	MCL	Stations: Banks	DMC	NEMDC
	mg/L			
Aluminum	0.2			
Detects/sample number		2/38	15/31	30/38
Range		0.02–0.08	0.01–0.06	0.01–0.37
Average		0.03	0.04	0.06
Median		0.03	0.04	0.02
Copper	1.0			
Detects/sample number		38/38	31/31	37/38
Range		0.001–0.007	0.002–0.005	0.002–0.005
Average		0.002	0.002	0.003
Median		0.002	0.002	0.003
Iron	0.3			
Detects/sample number		29/38	20/31	35/38
Range		0.005–0.066	0.005–0.117	0.013–0.323
Average		0.020	0.037	0.080
Median		0.014	0.037	0.047
Manganese	0.05			
Detects/sample number		32/38	7/31	37/38
Range		0.005–0.032	0.005–0.020	0.008–0.085
Average		0.014	0.011	0.040
Median		0.013	0.011	0.037
Silver	0.1			
Detects/sample number		0/38	0/31	-
Range		<0.001	<0.001	-
Zinc	5.0			
Detects/sample number		0/38	0/31	-
Range		<0.005	<0.005	-

Table 8-3 Summary of regulated constituents in drinking water having federal and State primary MCLs

Constituent	MCL	Stations: Banks	DMC	NEMDC
	--------	mg/L	--------	
Antimony	0.006			
Detects/sample number		0/20	0/17	-
Range		<0.005	<0.005	-
Arsenic	0.01			
Detects/sample number		38/38	31/31	37/38
Range		0.001–0.003	0.001–0.003	0.001–0.006
Average		0.002	0.002	0.003
Median		0.002	0.002	0.003
Barium	2.0 or 1.0 (DHS)			
Detects/sample number		0/29	1/30	-
Range		-	<0.05–0.05	-
Average		-	0.05	-
Median		-	0.05	-
Cadmium	0.005			
Detects/sample number		0/38	0/31	-
Range		-	-	-
Chromium (total)	0.1 or 0.05 (DHS)			
Detects/sample number		19/38	19/31	-
Range		0.004–0.008	0.003–0.009	-
Average		0.006	0.005	-
Median		0.006	0.005	-
Lead	0.015[a]			
Detects/sample number		0/38	0/31	-
Range		-	-	-
Mercury (inorganic)	0.002			
Detects/sample number		1/38	0/30	-
Range		<0.0002–0.0002	-	-
Average		0.0002	-	-
Median		0.0002	-	-
Nickel	0.1 (DHS)			
Detects/sample number		19/20	21/21	-
Range		0.001–0.002	0.001–0.002	-
Average		0.001	0.001	-
Median		0.001	0.001	-
Selenium	0.05			
Detects/sample number		12/39	4/15	-
Range		0.001–0.002	0.001–0.003	-
Average		0.001	0.002	-
Median		0.001	0.002	-

a. Action level that triggers treatment actions if exceeded in more than 10% of tap water samples.

Table 8-4 Summary of boron at MWQI stations

Station	Positive detects/ sample number	Range	Average	Median
		---mg/L---		
American and Sacramento River stations				
American River at E.A. Fairbairn WTP	0/37	-	-	-
West Sacramento WTP Intake	0/38	-	-	-
Sacramento River at Hood	0/160	-	-	-
Sacramento River at Mallard Island	25/35	0.1-1.2	0.4	0.3
San Joaquin River stations				
San Joaquin River near Vernalis	159/160	0.1-0.8	0.3	0.3
San Joaquin River at Highway 4	37/37	0.1-0.6	0.3	0.3
Delta channel stations				
Old River at Station 9	28/38	0.1-0.4	0.2	0.1
Old River at Bacon Island	15/30	0.1-0.2	0.1	0.1
Diversion stations				
Banks Pumping Plant	28/37	0.1-0.3	0.2	0.2
Delta-Mendota Canal	30/31	0.1-0.6	0.2	0.2
Contra Costa Pumping Plant	23/30	0.1-0.6	0.3	0.2
Agricultural drainage stations				
Bacon Island Pumping Plant	25/25	0.1-0.3	0.2	0.2
Twitchell Island Pumping Plant	35/35	0.1-0.2	0.1	0.1
Urban drainage station				
Natomas East Main Drainage Canal	35/41	0.1-0.2	0.2	0.2

Note: Boron is currently an unregulated constituent that requires monitoring.

Table 8-5 Summary of nitrate at 14 MWQI stations

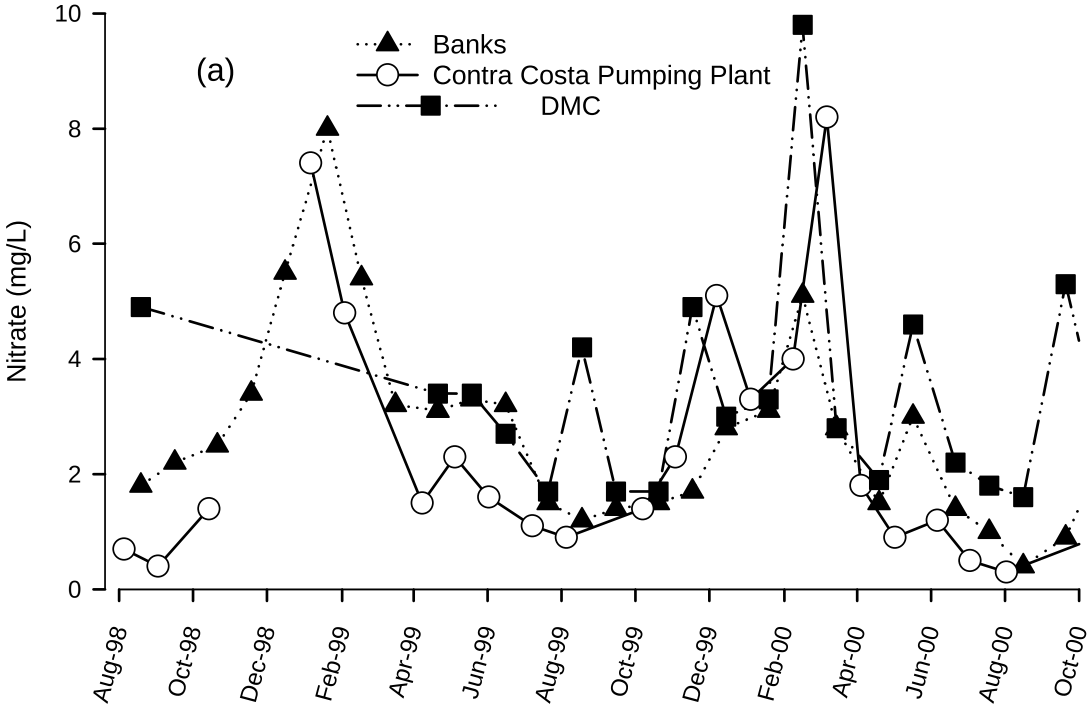
Station	Positive detects/ sample number	Range	Average	Median
		--------------------mg NO_3 /L----------------		
American and Sacramento River stations				
American River at E.A. Fairbairn WTP	9/25	0.1–0.8	0.3	0.2
West Sacramento WTP Intake	25/26	0.1–0.8	0.4	0.4
Sacramento River at Hood	112/113	0.1–12.4	0.8	0.5
Sacramento River at Mallard Island	23/23	0.9–8.2	1.7	1.4
San Joaquin River stations				
San Joaquin River near Vernalis	112/112	1.6–28.0	6.4	6.4
San Joaquin River at Highway 4	25/25	2.8–9.3	6.0	6.1
Delta channel stations				
Old River at Station 9	26/26	0.5–9.5	2.5	1.8
Old River at Bacon Island	25/25	0.1–6.4	1.8	1.4
Diversion stations				
Banks Pumping Plant	28/28	0.4–8.0	2.7	2.7
Delta–Mendota Canal	20/20	1.6–9.8	3.4	2.9
Contra Costa Pumping Plant	22/22	0.3–8.2	2.4	1.5
Agricultural drainage stations				
Bacon Island Pumping Plant	14/19	0.4–13	3.8	2.8
Twitchell Island Pumping Plant	23/23	0.1–12	2.8	1.1
Urban drainage station				
Natomas East Main Drainage Canal	36/36	1.8–21.0	10.0	9.4

Note: Nitrate was determined by Standard Method 4500 except at NEMDC where EPA Method 300 was used.

Table 8-6 Summary of nutrient data at the Banks Pumping Plant

	Ammonia (mg N/L)	Nitrate + nitrite (mg N/L)	Kjeldahl nitrogen (mg N/L)	Orthophosphorus	Total P
				--------------(mg P/L)---------------	
Detects/sample number	29/29	29/29	29/29	29/29	29/29
Range	0.02–0.15	0.13–1.20	0.3–0.8	0.04–0.15	0.07–0.16
Average	0.06	0.57	0.5	0.07	0.11
Median	0.05	0.51	0.4	0.06	0.10

Figure 8-1 Nitrate at three diversion stations and two river stations



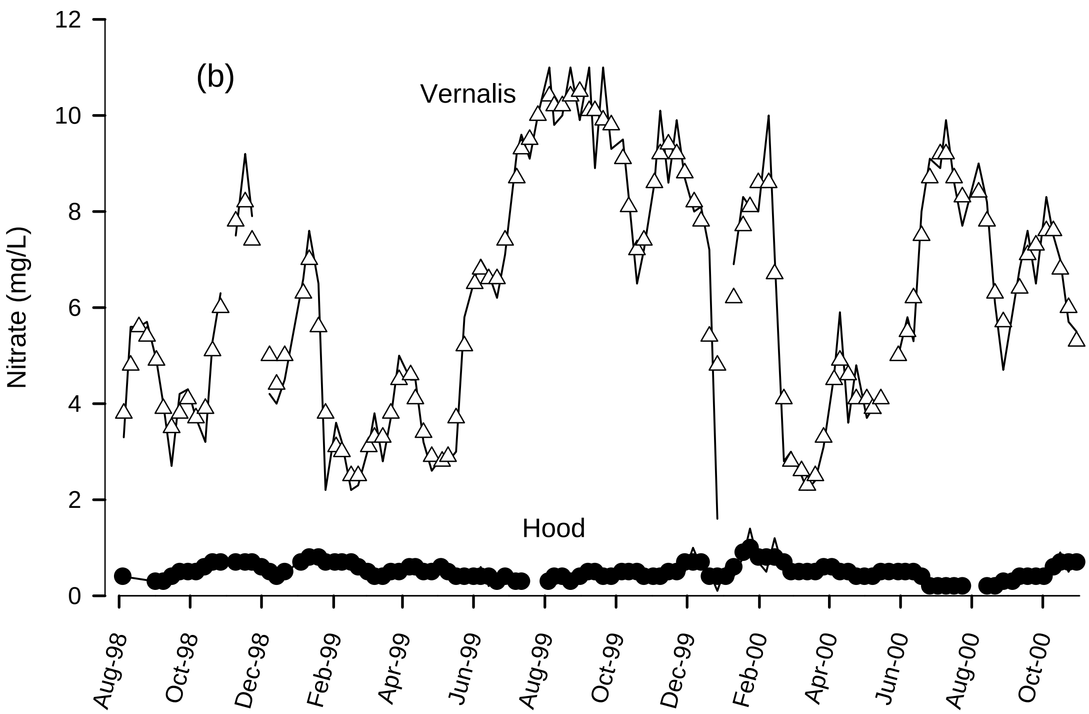


Figure 8-2 Nutrients at the Banks Pumping Plant Station